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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : A61N 2/04 — A1

(11) International Publication Number: WO 92/03185

(43) International Publication Date: 5 March 1992 (05.03.92)

(21) International Application Number: PCT/GR91/00011

(22) International Filing Date: 25 July 1991 (25.07.91)

(30) Priority data:
900100630 24 August 1990 (24.08.90) GR

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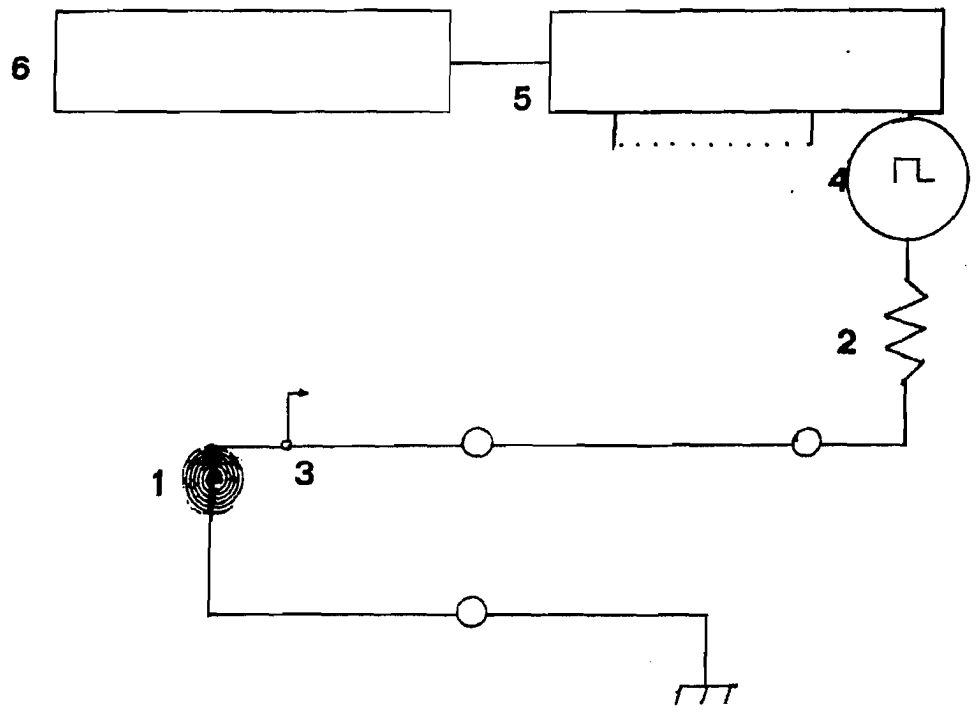
(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, SD, SE, SE (European patent), SN (OAPI patent), SU*,TD (OAPI patent), TG (OAPI patent), US.

Published
With international search report.

(54) Title: ELECTRONIC DEVICE FOR SMOOTHING DYSFUNCTIONS OF THE CENTRAL NERVOUS SYSTEM IN CONJUNCTION WITH THE USE OF BIOMAGNETOMETER

(57) Abstract

A device for smoothing epileptic foci and seizures consists of one or more generators (4) of alternating low voltage at a given frequency from 2-7 Hz, which supply a given number of selected coils (1) from one or more groups of similar coils properly arranged. These coils are supplied by a current whose form, amplitude and frequency are controlled by a microprocessor (5). The currents in the coils (1) generate magnetic fields which have similar characteristics to the magnetic fields emitted by the epileptic foci. The characteristics (frequencies, power, amplitudes and coordinates) of those fields are determined with the help of a biomagnetometer (SQUID) and a proper software for data analysis. The data are processed by the microprocessor (5). A second microprocessor (6) controls the general operation of the device.



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Electronic device for smoothing dysfunctions of the central nervous system in conjunction with the use of Biomagnetometer

The present invention referred to the electronic device for smoothing dysfunctions of the central nervous system with the use of the Biomagnetometer consisting either from a generator of alternating voltage of low frequency which can produce a given frequency from 2 to 7 Hz and which supplies a given number of selected coils from one group or more groups of similar coils for the production of alternating magnetic fields the intensity of which is regulated from microprocessors, or from generators of alternating voltage of low frequency which can produce each one its own frequency from 2 to 7 Hz and which supply simultaneously a definite number of selected coils for the production of alternating magnetic fields of regulated intensity and frequency from microprocessors. The magnetic fields which are simultaneously produced from the coils must be parallel to the alternating magnetic fields which are emitted from the epileptic foci of the brain. The power spectra and frequencies of the emitted magnetic fields of the coils are of the order of the magnetic fields which are emmited from the epileptic foci, that is from 0.5 pT to 7.5 pT. The limit of the intensities can be extended. Satisfactory results can be obtained using 64 of similar coils as is the number of the measuring points in the left and right brain hemispheres. It is clear that first we should localize the epileptic foci with the help of the SQUID. The present device for smoothing epileptic foci is adjusted with the use of the SQUID which gives all the characteristics of the epileptic foci or any other brain malfunction. Thus the first step is to localize the epileptic foci with the use of the SQUID and after to adjust properly the electronic device of the present invention according to the characteristics properties of the localized epileptic foci.

Prior to the present innovation were the previous publications by the innovators P.A.Anninos and N.F.Tsagas (Brain re-

search Bulletin, Vol.16,1986, International Journal of Neuroscience Vol.37,1987). The device, according to the present invention, has the characteristic point that solves the problem of smoothing the epileptic foci or any other dysfunctions of the central nervous system without the use of the invasive methods. It is perfectly safe because the applied alternating magnetic fields are of low frequency (2-7 Hz) and low intensity from 0.5 pT-7.5 pT. This problem was solved with the use either of one generator of low alternating voltage and frequency which can produce a given frequency from 2-7 Hz and which supplies a given number of selected coils for the production of alternating magnetic fields of which the intensity and frequency are regulated by microprocessors or from generators of low alternating voltage and frequency which can produce each one its own frequency from 2-7 Hz and which can supply simultaneously a given number of selected coils for the production of alternating magnetic fields of which the intensity and frequency are adjusted with the help of microprocessors. The device is activated with the necessary characteristic elements of the epileptic foci, which we obtained with the use of the biomagnetometer SQUID, and which are properly stored in one integrated circuit of one microprocessor. The proper storage of the above data is done with the help of a proper SOFTWARE which is written in basic computer language invented by the first two inventors. With this computer program we read the data which are stored in the computer disk or diskette during the analysis of the data which we have recorded from the epileptic foci of a patient with the help of the SQUID for all the 64 or 128 points of skull. These data are stored with the above software program in one matrix with three columns where in the first column we store the left temporal or occipital or frontal points where as in the other two columns we store the frequencies and intensities of the fields which are emitted from each point. The same thing occurs for the right temporal, occipital and frontal regions of the skull. The correspondence between the points it is seen in the table A and

and figure 1. With the above microprocessor placed in the electronic device for smoothing is accomplissed its activation with a result that every coil to emit an alternating square wave magnetic field of a given frequency and intensity as it is seen in figure 2. The figures were obtained by checking every one coil with the help of the SQUID, so that we get first the wave form of the emitted magnetic field (figure 2a) and the corresponding power spectrum (figure 2b) which gives the fundamental frequency which is emitted from the coil and which must be the same with the frequency and power of the magnetic field which is emitted from the epileptic focus of the corresponded measured point as it is stored in the diskette.

The advantage of this method over the keyboard which would required in order to keyboard the data of the epileptic foci and to store them it is very clear since we don't have the human factor which otherwise could result in fault storage of the above characteristic of epileptic foci and furthermore the storage is made faster depending on the computer running time of the SOFTWARE which was invented by the first two inventors.

One way of applying the electronic invention is described below by reffering to the figures which are with it and which they explain with clarity and technicaldetails for understanding and avoidness of any misunderstanding. The figure 1 of the invention gives the tables for the arrangement of the 32 measured points with the help of the Biomagnetometer of the left and right temporal hemisphere respectively as well as the reference points T3 and T4 respectively. The same arrangment of the points is done for the measurements of frontal and occipital hemispheres.

The figure 2a of the invention gives the waveform of the magnetic field which is emitted from one of the 64 coils of the electronic device of the present invention for the time interval of one second as it is recorded by the Biomagnetometer. As it is seen from the figure the frequency of the emitted magnetic field is 8 Hz. The figure 2b of the present

invention gives the power spectrum of the wave form given in figure 2a from which it is seen its power amplitude and frequency which is emitted from one of the 64 coils as it is recorded from the Biomagnetometer. The figure 3 of the invention gives the spiral form and the arrangement of the 32 coils which are used for each hemisphere for smoothing of epileptic foci. The coils consist from flexible metal or alloy of proper specific resistance and are printed in a flexible plate of proper flexible resistant meterial. The figure 4 of the invention gives the assembly circuit of the spiral coil (1) which is one of the coils of the flexible plate with the printed coils in figure 3. The resistance (2) of the circuit can take the aproximate value of 100 kΩ. The circuit includes a contact-breaker sensor (3) of the circuit which activates an alarm-system. The number of the above circuits is defined by the number of the coils that is mxn where (m) is the number of the printed coils in a plate which can be less, equal or more than 32 and (n) is the number of the plates which can be less equal or more than 4. The circuit is supplied with alternative current of square wave or some other wave form (4) which is controled by a microprocessor (5) and this microprocessor controls and all the other coils. Also the microprocessor (5) selects and energizes all the nearest coils to the epileptic foci. These coils will be supplied by the alternative current of which all the characteristics like wave form, amplitude and frequency are controled by the microprocessor (5). The second microprocessor (6) controls the first microprocessor (5) and general it controls the normal operation of the device.

In Fig.5 of the invention, the block diagram of one of the 64 identical stages used in the electronic system is shown. Each one of these stages generates a pulse train of specific frequency and amplitude which drives one of the coils. All the stages are connected to the clock input (11) and to the data bus (12) of the microprocessor (5). Each one of the 64 identical stages is connected to a dedicated enable line (16). The description of the operation is as folows: as soon as one enable line (16) of the above 64 identical stages, is driven in low logic level under the control of the micropro-

cessor (5), the data from the data bus (12) which is 8 bit long is latched in the corresponding latch (13) until a new enable signal takes place. These 8 bits determine the frequency and the amplitude of the pulses of the specific stage. The first four bits are fed through the connection (14) to the programmable frequency divider (10). These bits determine how much the pulse rate (frequency) is to be reduced. Next to this a fixed divider reduces the pulse rate further more by a fixed frequency division (9). Up to this point the amplitude of the pulses remains unchanged. Stage (8) is a programmable gain amplifier which defines the final amplitude of the pulses. The rest 4 bits which are latched from the data bus of the microprocessor are used for this purpose. In the same manner the frequency and the amplitude of all the 64 stages is defined. The stages can be less, equal or more than 64.

The table A gives the way by which are recorded the characteristics of each point which correspond in one epileptic foci and which are stored in one integreated circuit of microprocessor which energizes the electronic device for the magnetic smoothing of epileptic foci. The left and the right part of this table gives the points of the left and right hemisphere of the brain respectively. The symbols pt.≠, B(PT), Hz represent the points which measured on the patient skull, the amplitudes of the power spectrum in PT and their frequencies for the smoothing of the epileptic foci.

Claims

1. The present electronic device, for the smoothing of dysfunctions of central nervous system in conjuction with the biomagnetometer SQUID, consists of either of one generator of regulating alternating low voltage which produces a given frequency from 2-7Hz and which supplies a definite number of selected coils of one group or more groups of similar coils properly arranged to produce alternating magnetic fields of square wave form of which the intensity and frequency are regulated from microprocessors or from generators of alternating regulated low voltage which produce each one its own frequency from 2-7Hz and which supply simultaneously a definite number of selected coils of one or more groups of similar coils properly arranged in series which produce alternating magnetic fields of square wave form of which the intensity and frequency are regulated from microprocessors. These magnetic fields have similar characteristics with the emitted alternating magnetic fields of the epileptic foci which are determined with all charactristics of frequencies, power amplitudes and coordinates which are produced with the help of the biomagnetometer SQUID for the disorganization of neuronal generators which emit a resonated magnetic energy from the epileptic foci.

2. The present electronic device for the smoothing of dysfunctions of the central nervous system in conjunction with the biomagnetometer SQUID according to the claim 1 is characterized from that it can have one microprocessor which is used for the storage of the characteristic data which are read with the help of a proper software from one diskette during the epileptic foci diagnosis of a patient with the help of the SQUID.

3. The present electronic device for smoothing dysfunctions of the central nervous system in conjunction with the biomagnetometer SQUID according to the claims 1 and 2 is characterized from that the effectiveness of the invention func-

tion is based to the necessity to use the biomagnetometer SQUID, at least in the first smoothing of the patient during which time is done the first calibration of the electronic device. The points which form one point matrix of rectangle shape (gigure 1) are placed around the reference points of the 10-20 international point system for electrode placement. The reference points are T3, T4, P3, P4, F3 and F4 for left or right temporal hemisphere, left or right occipital and left or right frontal brain regions respectively. The 32 points are placed with one self adhesive etikete on a plastic hat which is placed on the skull of the patient in which prior have been defined the reference points.

The 32 points which are equally spaced by 1.5 cm as we stated above are placed in perfectly defined positions on the skull with the help of self adhesive etikete if we have defined previously the coordinates of the reference points that is if we know the coordinates of the reference points then we know also the coordinates of all 32 points of the map and therefore we know the coordinates of the epileptic foci. After we place the SQUID sensor 3 mm above each measuring point we take 32 consecutive records of 1 sec duration each from each point and we digitize with sampling frequency of 256 Hz. Then we do Fourier statistical analysis in order to find the power spectrum of the magnetic amplitude distribution for a given frequency or a given grange of frequencies with the help of electronic computer techniques we can connect all equal power spectra amplitudes for a given frequency or a given frequency domain so that to construct maps which are called ISO-SA maps. From these maps and from the density of the ISO contour lines we can infer conclusions if there are epileptic foci and also the coordinates and the spectra power amplitudes of the epileptic foci.

Finally from this analysis, once we have localize the epileptic foci with the help of spectral analysis, we can find the frequency of the magnetic field emitted from each epileptic foci. These data are stored in one computer diskette from which with a proper software are stored in one micro-

processor by which it is possible to energize the electronic device for smoothing in order to emit back alternating magnetic fields of similar characteristics with those which emitted from the epileptic foci. Thus it is seem that the device is completely related with the measurements of the SQUID which is necessary for the calibration of the electronic device of the present invention. With the smoothing of the described electronic device we accomblish in a direct and non invasive manner the smoothing of the epileptic foci.

4. The present device for smoothing dysfunctions of the central nervous system according to the claims 1,2 and 3 is characterized from that the smoothing disappearance of epileptic foci with the help of microprocessor and the software does not come the human factor for the data transfering from the diskette to the microprocessor and therefore we avoid errors and simultaneously we gain time because the data transfering is accomplished with the computer system speed that we use. The smoothing and the cancellation of epileptic foci remains for several days or months and is due to the fact that with the influence of the external varying magnetic field we induce inhibitory potential in the neuron synapses in the brain regions where we apply the described electronic device.

5. The present device for the smoothing of the cenrtal Nervous System dysfunctions according to the claims 1, 2, 3 and 4 consists of a great number of circuits mxn, where (m) is the number of spiral coils made by flexible metal or alloy which are printed on (n) plates made by appropriate flexible material of great strength. The number (m) can be less, equal or more than 32 and the number (n) can be less equal or more than 4. Each one of the above circuits consists of a spiral coil (1) of which one end is earthed and the other end is conected with an alternative current generator (4) through a resistor (2) and one contact-breaker sensor (3) which activates an alarm system. All the circuits are cont-

roled by one microprocessor (5) which selects and energizes all the nearest coils to the epileptic foci. These coils will be supplied with the alternative current which has all the appropriate characteristics like square or any other wave form amplitude and frequency which have found emitted from the epileptic foci using the biomagnetometer. All these characteristics are controled by the microprocessor (5).

6. The present device for the smoothing of the central Nervous System dysfunctions according to the claim 1,2,3,4 and 5 is characterized by the fact that in the electronic device of the invention there is a second integrated circuit of a microprocessor (6) which controls the first microprocessor (5) so that to give an alternative current of appropriate waveform, amplitude and frequency to the appropriate selective coils which are nearest to the epileptic foci and therefore to generate the appropriate alternative magnetic fields. Also the second microprocessor controls any faults of the device and the appropriate selection of the coils which must be supplied by the appropriate alternative current.

7. The present device for the smoothing of the Central Nervous System dysfuctions according to the claims 1,2,3,4,5 and 6 is characterized by the fact that there is the possibility of individual frequency and amplitude setting for each pulse train of each spiral coil which is implemented using a programmable frequency divider (10) and a programmable gain analogue amplifier (8).

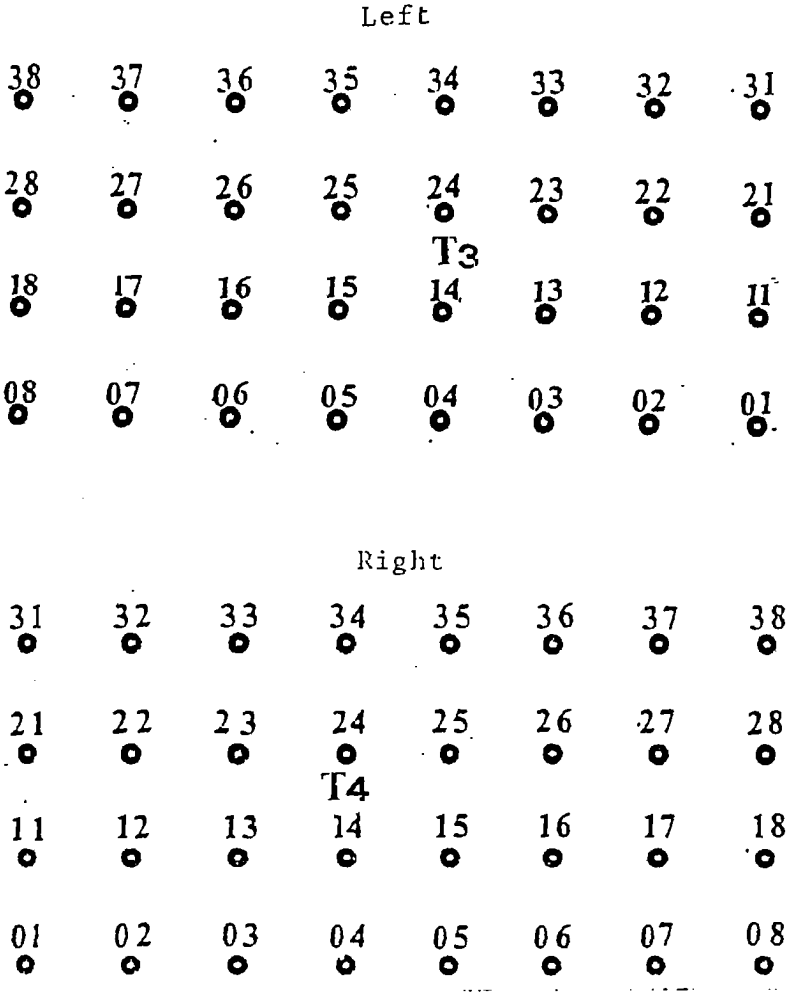
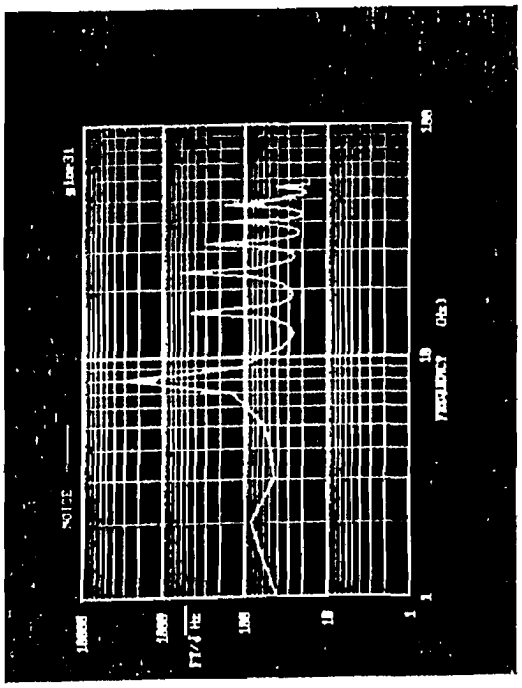
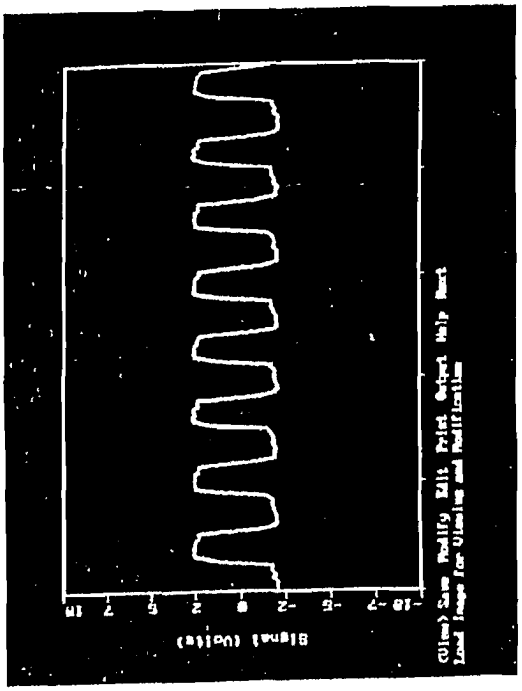

Left
38 37 36 35 34 33 32 31
28 27 26 25 24 23 22 21
T3
18 17 16 15 14 13 12 11
08 07 06 05 04 03 02 01
Right
31 32 33 34 35 36 37 38
21 22 23 24 25 26 27 28
T4
11 12 13 14 15 16 17 18
01 02 03 04 05 06 07 08

Fig. 1



(B)



(α)

Fig. 2

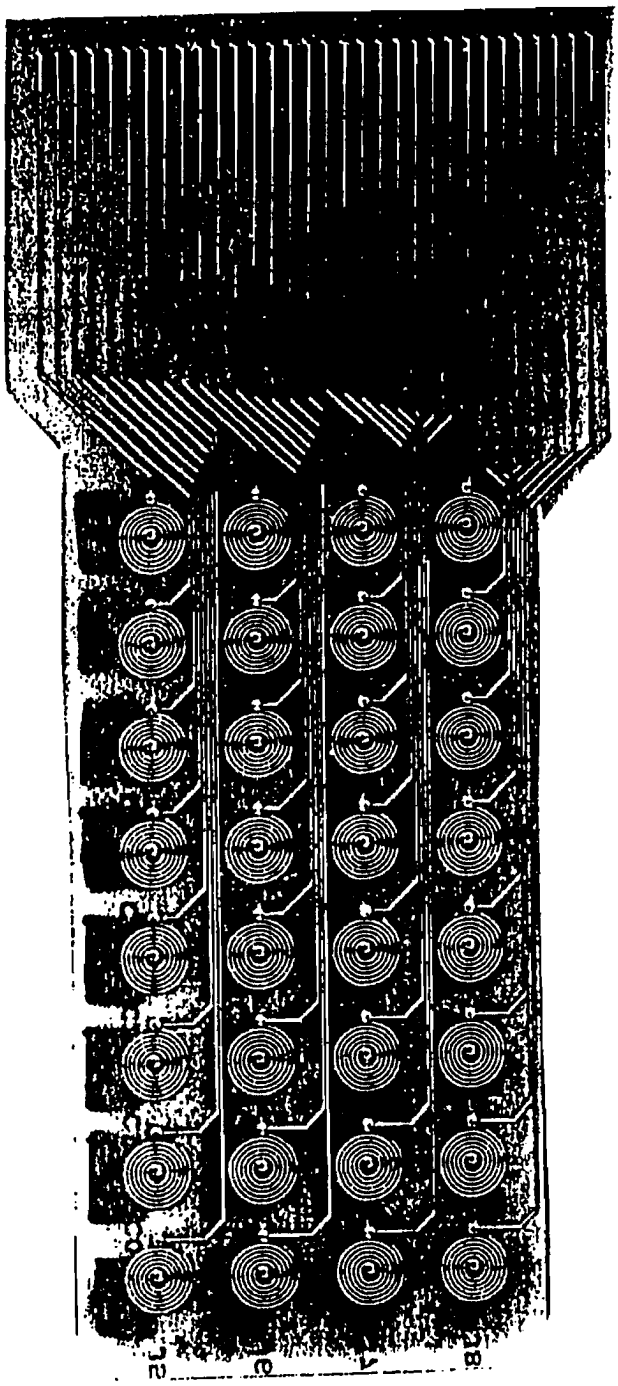


Fig. 3

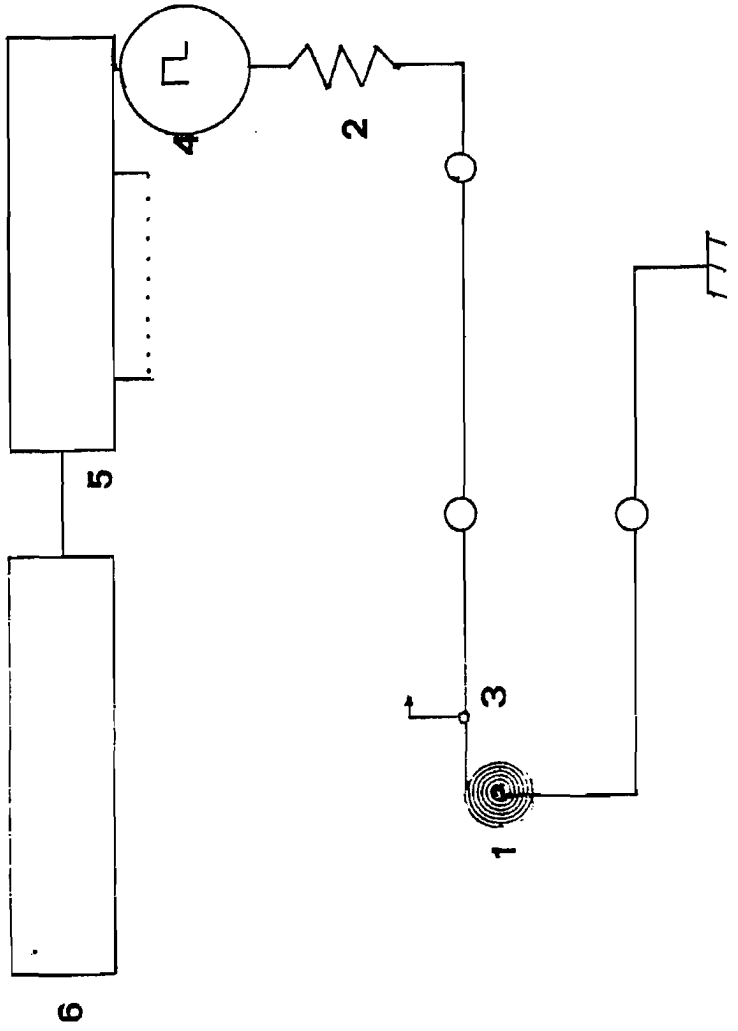


Fig- 4

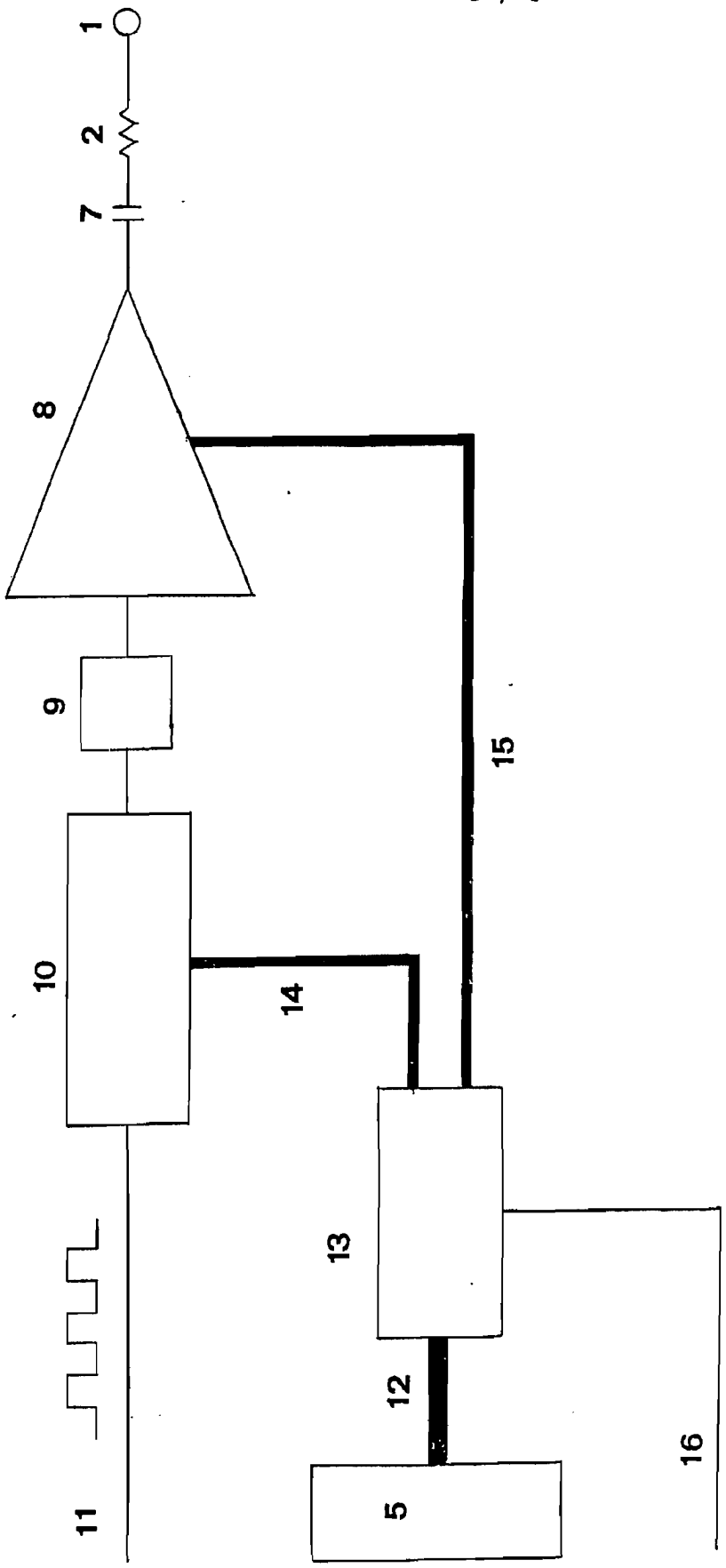


Fig.5

Table - A

Patient Name :LRGANA

Code : File Name :Irgana, ERG Dated :07-01-1990

LEFT SIDE

Pt.#	Hz	B(T)	Pt.#	Hz	B(T)
01	2	6	21	2	6
02	7	6	22	5	6
03	3	6	23	5	6
04	2	6	24	7	6
05	5	6	25	2	6
06	5	12	26	7	6
07	2	12	27	7	12
08	2	12	28	2	6
11	2	6	31	2	6
12	7	12	32	6	6
13	7	12	33	2	6
14	2	6	34	2	6
15	7	6	35	7	6
16	6	12	36	7	6
17	2	12	37	2	6
18	2	6	38	2	6

RIGHT SIDE

Pt.#	Hz	B(T)	Pt.#	Hz	B(T)
01	4	6	21	5	6
02	2	6	22	4	6
03	5	6	23	4	6
04	2	6	24	4	6
05	2	6	25	4	6
06	2	6	26	7	6
07	5	6	27	3	12
08	2	6	28	2	6
11	2	6	31	5	6
12	2	6	32	4	6
13	4	12	33	4	6
14	2	6	34	4	6
15	2	6	35	4	6
16	6	6	36	2	6
17	2	6	37	2	6
18	5	6	38	2	6

INTERNATIONAL SEARCH REPORT

International Application No PCT/GR 91/00011

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 A61N2/04

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
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Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
A	BERNHARD KRAMER (editor): "THE ART OF MEASUREMENT : Metrology in fundamental and applied physics" 1988, VCH, Weinheim (DE) New York (US) ; M. Hoke, SQUID-based measuring techniques - A challenge for the functional diagnostics in medi cine see pages 287 - 333	1-3
A	US,A,4940453 (J.A. CADWELL) 10 July 1990 see the whole document	1-3
A	EP,A,84019 (LKH AG) 20 July 1983 see page 1, line 1 - page 4, line 6; figure 1	1-3
A	EP,A,99734 (TESLA, KONCERNOVY PODNIK) 01 February 1984 see the whole document	1-4

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
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International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	FERRIGNO A.

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A	DE,A,2707574 (A. GÖDDE) 24 August 1978 see the whole document ---	1-4

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GR 9100011

SA 49590

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US-A-4940453	10-07-90	None	
EP-A-84019	20-07-83	None	
EP-A-99734	01-02-84	SU-A- 1613119 US-A- 4693238	15-12-90 15-09-87
DE-A-2707574	24-08-78	None	